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ABSTRACT

The Washington Pre-College (WPC) Testing Program, together with experimental tests administered in Spring 1969, was analyzed to instigate a new guidance system for high school juniors and seniors. Initially, WPC employed predictors established on an already selected intellectual group. New test predictors were needed to match the complexity of the differences in educational opportunities, both vocational and academic, open to high school seniors. The Spring 1969 testing yielded predictive measures on 27,000 juniors. Item analysis resulted in shortened forms of all standard tests of the battery and revised forms of experimental tests. Based on this information and correlations among all tests, recommendations are made for WPC placement testing of seniors in Spring 1970. References are included. (Author/ES)

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Evaluation of Experimental Tests Administered Spring 1969 with the Standard Washington Pre-College Test Battery

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The Washington Pre-College (WPC) Test Battery together with experimental tests administered spring 1969 were analyzed to accomplish several goals in keeping with long-range plans for developing an entirely new guidance system for high school juniors and seniors. Item analyses resulted in shortened forms of all standard tests in the battery and revised forms of experimental tests. On the basis of this information and the correlations among all tests recommendations are made for WPC experimental testing spring 1970.

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Over the next seven years the Washington Pre-College (WPC) statewide testing program plans to replace the standard battery in use since 1964 with an entirely new array of predictor and placement tests. One intent of the development and validation of new tests is to give the Program complete control over test materials, but there are other compelling reasons. WPC predictor variables now include age, sex, six high school (HS) GPA's and 12 tests: Vocabulary, English Usage, Spelling, Reading Speed, Reading Comprehension, Data Sufficiency, Quantitative Judgment, Functional Relationships, Applied Mathematics, Mathematics Achievement, Spatial Ability, and Mechanical Reasoning. Although these tests were constructed for the Program in 1962-63 by Educational Testing Service, they represent substitutes for the initial battery of tests selected according to the differential model in 1954 (Lunneborg, 1966). As a result predictors are employed which have been established as useful for discriminating solely among academic courses at one university (University of Washington). This means that the current Program is based upon the decision-making needs of a select group in the middle to upper range of intellectual potential choosing among University curricula, e.g., to major in psychology vs. oceanography. Although the Program's success rests on the established ability of these predictors to work throughout the state, in other schools, and for other course areas (Cory, 1968; Lunneborg, 1966; Lunneborg & Lunneborg, 1969), the desired differential aspect of prediction for these new and always expanding course criterion areas is questionable. The current battery is thus not meeting the needs of the bulk of high school seniors, i.e., those who must choose among vocational-technical programs or between these and an academic curriculum, students spanning the range of intellectual aptitude, students starting higher education in the community

college setting. Thus, new test predictors must be developed to match the complexity of the differences among educational experiences open to high school seniors in the 1970's.

The solution to these problems rests with the construction and evaluation of new tests. Test predictors of student success in a host of college academic courses and an equally large number of vocational/technical courses must be identified and selected for all post-high school institutions in the state. It is also essential that the tests developed are capable of meeting the needs of both academic and vocational institutions for placement and classification of students. In order to provide for the maximum articulation of the guidance process for individuals, a given school must be able to use test scores to place freshmen in its various levels of introductory English, to determine the eligibility of prospective vocational trainees for sheet metal, welding, sales, etc., and to give advanced credit. Thus, while continuing to place greatest stress upon its unique differential prediction character, the Program would like to provide its participants with two separate kinds of output--prediction and placement data. Prediction testing would be done in spring of the HS junior year and placement testing in spring of the HS senior year. Although all students would complete the same predictive battery, placement testing would be tailored to student's background and his choice of college and intended area of study.

This plan for evolving a comprehensive guidance program for high school graduates naturally will not stop with the construction and selection of differential predictors. Once tests have been selected, normative and validational data must be collected at all institutions to provide students and counselors with interpretive materials.

Testing with HS juniors spring 1969 was accomplished with the following goals in this long-range test development plan in mind:

(1) Item analyses of the eleven current WPC (Form B) tests (Reading Speed excluded) on the basis of which short forms of these 11 tests would be devised for future use.

(2) Evaluation of tests which might replace existing battery elements, i.e., Spelling and Mathematics Proficiency.

(3) Evaluation of tests which might extend the existing battery, i.e., inasmuch as the WPC program intends that the new battery contain the factor complexity of the GATB, certain GATB tests were given together with experimental materials designed to measure the same things.

Experimental test materials were divided into nine sets which were administered to nine student samples roughly equal in terms of high school size. The nine sets of experimental tests were:

(1) GATB Forming Metal Objects (FMO) and Alpha Numeric Assembly A (ANA)

(2) FMO and Alpha Numeric Assembly B (ANB)

(3) GATB Name Matching (NM) and Perceptual Accuracy A (PAA)

(4) NM and Perceptual Accuracy B (PAB)

(5) Vocational Interest Inventory (VII)

(6) GATB Mark Making (MM) and Motor Coordination (MC)

(7) Spelling (Spe)

(8) Mathematics Proficiency A (MPA)

(9) Mathematics Proficiency B (MPB)

As Table 1 indicates by N_{tested} actual numbers of students receiving each experimental test were considerably greater than the numbers of cases used for

correlations with the standard battery. This resulted from the unavailability of WPC test results for students tested in the eastern half of the state and processed at Washington State University. Thus, although the item analyses of the experimental tests are based on statewide samples, both the item analyses of the standard WPC tests and the correlation of WPC tests with experimental tests are restricted to western Washington HS juniors. Approximately 19,000 Ss were tested in the west; 8,000 in the east.

Item analyses of current WPC tests. These analyses were done using successive groups of 2,500 cases from the western sample. The focus of each was a recommendation for the short form of that test.

(1) WPC English Usage (Section A, 60 items in 30 minutes; Section B, 30 items in 20 min.)

Mean score was 39.4, SD 15.0, KR-21 reliability .93 for 2515 cases. Two items should be excluded from further testing (numbers 36 and 80) as they had point biserial correlations of -.01 and .03 with the total score due apparently to poor construction. A half-length test of English Usage can be formed by dropping from Section A items 3, 4, 5, 7, 11, 12, 15, 16, 18, 21, 23, 24, 25, 29, 30, 33, 34, 36, 38, 39, 40, 43, 45, 46, 49, 50, 52, 55, 58, and 60 and from Section B items 63, 65, 66, 69, 70, 71, 74, 77, 78, 79, 80, 81, 85, 89, and 90. The excluded items were the least discriminating items.

(2) WPC Spelling (50 items, 10 minutes)

Mean score was 15.4, SD 8.6, KR-21 reliability .87 for 2515 cases. One item, 23, although keyed correctly had a point biserial r of -.07 with total score (too difficult) and should be excluded from further testing. This test could be shortened to a 40-item, 8-minute test by dropping items 2, 7, 13, 19, 23, 26, 31, 40, 44, and 50, the poorest items of each successive four.

(3) WPC Reading Comprehension (40 items, 25 minutes)

Mean was 17.6, SD 7.3, KR-21 reliability .88 for 2436 cases. Two items with negative point biserial r's should have their keying reversed: correct keying is E for item 17 and C for item 18. Shortening Reading Comprehension is a bit difficult to predict timing for. However, if item 5 is removed from the first reading selection, and 7 and 8 from the second, 16 from the third, 26 from the fourth, 33 from the sixth and the seventh selection is dropped entirely, a 15-minute time limit would seem reasonable.

(4) WPC Mechanical Reasoning (35 items, 25 minutes)

Mean was 7.3, SD 7.2, KR-21 reliability .88 for 2436 cases. Two items, 21 and 33, have been miskeyed. Reducing to a 20-item, 15-minute test can be accomplished by dropping items 1, 4, 7, 8, 12, 13, 16, 17, 21, 22, 25, 28, 29, 33, and 35.

(5) WPC Spatial Ability (24 items, 15 minutes)

Mean was 9.3, SD 4.8, KR-21 reliability .85 for 2436 cases. Item 22 dispite correct keying is too difficult because of poor construction (r = -.01) and should be dropped. This test could be reduced to a 16-item, 10-minute test by dropping items 2, 3, 7, 10, 17, 18, 22 and 24.

(6) WPC Applied Mathematics (30 items, 20 minutes)

Mean was 9.6, SD 4.8, KR-21 reliability of .74 for 2436 cases with no particular item problems. Applied Math could be shortened to a 20-item, 13-minute test by dropping items 2, 3, 10, 11, 14, 15, 23, 24, 28 and 30. Relatively low reliability makes this a low priority change.

(7) WPC Vocabulary (100 items, 25 minutes)

Mean was 41.7, SD 17.2, KR-21 reliability .95 for 2500 cases. Item 47 though correctly keyed is too difficult (point biserial $r = .01$) to be retained. To reduce to a 60-item, 15-minute test, the following items should be eliminated: 4, 5, 7, 8, 11, 13, 17, 20, 22, 24, 28, 29, 34, 35, 36, 39, 43, 45, 46, 47, 51, 54, 56, 57, 63, 64, 67, 68, 71, 75, 77, 79, 81, 82, 87, 90, 92, 94, 99, 100. (Picking best three out of sequences of five items.)

(8) WPC Quantitative Skills Part A, Data Sufficiency (15 items, 10 min.)

Mean of 6.0, SD 3.1, KR-21 reliability .74 for 2412 cases. It is not proposed that this test be shortened because of its already short time limit and limited number of items, all of which were good.

(9) WPC Quantitative Skills Part B, Quantitative Judgment (30 items, 10 min.)

Mean of 12.7, SD 6.3, KR-21 reliability .89 for 2412 cases. Good reliability for a short time test, and all items were good. It is not proposed that Quantitative Judgment be shortened.

(10) WPC Quantitative Skills Part C, Functional Relationships (15 items, 10 min.)

Mean of 3.0, SD 3.0, KR-21 reliability .67 for 2412 cases. Because of this relatively low reliability and because this test is not weighted for any predictions, it is proposed that the Quantitative Skills test be shortened by dropping this Part entirely.

(11) WPC Mathematics Achievement (45 items, 60 minutes)

Mean of 14.7, SD 8.6, KR-21 reliability .90 for 2412 cases. Shortening the test to a 30-item test, it is proposed to drop items 1, 2, 6, 10, 13, 18, 20, 22, 25, 29, 33, 36, 39, 41 and 44. A new test should be constructed out of the remaining 30 items plus the 20 experimental Math Proficiency items (described in next section) ordered by difficulty. Separate scorings of the "low level" and "high level" parts should be provided. The combined tests should take one hour testing time.

A summary of shortened versions of current WPC tests:

	Full Length		Shortened		
	Items	Minutes	Items	Minutes	Savings
1. Booklet I					
English Usage, A	60	30	30	15	
English Usage, B	30	20	15	10	
Spelling	50	10	40	8	
Reading	40	25	29	15	
Total		85		48	35 min.
2. Booklet II					
Mech Reason	35	25	20	15	
Spatial Abil	24	15	16	10	
Applied Math	30	20	20	13	
Total		60		38	20 min.
3. Booklet III					
Vocabulary	100	25	60	15	
Quant Skills	60	30	45	20	
Math Achiev	45	60	50**	60	
Total		115		95	20 min.

** including 20 Math Proficiency items.

Evaluation of replacement tests. Two tests were constructed locally as potential replacements for WPC Spelling and Mathematics Achievement. The latter was written by a WPC Research subcommittee.

(1) Spelling Test (50 items, 15 minutes)

Mean score was 24.65, SD 7.92, KR-21 reliability was .84 based on 3585 cases. Time limit was judged appropriate from the mean, SD, and the fact that the distribution of scores was symmetric tailing off to zero frequencies for very low and very high scores. Item analysis identified 10 items with discriminations (point-biserial correlations with total score) less than .25. Because of the homogeneity and good distribution of item difficulties it is proposed that these 10 poor items (6, 8, 11, 23, 24, 26, 40, 41, 47, 50) be eliminated and the time limit shortened to 10 minutes. As Table 1 indicates the experimental Spelling test correlated .70 with WPC Spelling. Alternate forms of this experimental test were found earlier to correlate .61-.85 with WPC Spelling (Gibson, 1969).

(2) Mathematics Proficiency (25 items, 20 minutes)

Mean score was 16.03 on Form A, 15.48 on Form B, SD of 5.3 on both forms. As expected the test was easy and had a KR-21 reliability of .86 (N = 2302 for A, N = 1500 for B). It is proposed that two poorly discriminating items (Form A 3 and 8) and three relatively difficult items, i.e., with proportion passing less than .46, (Form B 3, 5, and 9) be eliminated and the resulting 20 items pooled with a shortened form of WPC Mathematics Achievement Test with 1 hour total testing time. From Table 1 the two forms correlated .81 and .77 with WPC Math Achievement, and .74 and .71 with WPC Applied Mathematics.

Table 1

Correlations of WPC Experimental Tests Given Spring 1969 with Standard WPC Battery

(Decimal points omitted)

Experimental tests	WPC standard battery elements														
	VO	EU	SP	RS	RC	DS	QJ	FR	AM	MA	SA	MR	N_r	N_{tested}	$N_{item\ analysis}$
GATB Forming Metal Objects	31	29	19	21	33	33	43	34	41	43	52	46	1,836	2,625	2,653
Alpha Numeric Assembly A	10	12	12	26	13	07	18	20	20	16	22	15	876	1,037	1,039
Alpha Numeric Assembly B	11	15	16	22	16	11	23	15	18	21	22	23	829	936	940
GATB Name Matching	23	32	39	23	27	20	24	21	24	22	15	-05	3,594	4,512	
Perceptual Accuracy A	21	30	28	19	25	23	29	26	35	34	27	07	1,142	1,279	1,279
Perceptual Accuracy B	19	25	25	19	24	24	30	29	33	30	28	10	1,738	2,462	2,462
GATB Mark Making	11	19	22	14	14	01	03	06	03	-00	-01	-18	1,686	2,264	
Motor Coordination	-11	-05	-00	09	-00	-08	-04	-04	-05	-08	03	01	752	1,245	
Spelling	51	61	70	24	46	27	32	27	32	34	20	-01	2,425	3,584	3,585
Mathematics Proficiency A	43	53	35	24	49	64	79	58	74	81	51	44	1,194	2,301	2,302
Mathematics Proficiency B	44	48	38	25	50	61	77	55	71	77	44	41	1,321	1,461	1,500

Evaluation of new tests not represented in old battery.

(1) GATB Mark Making was given solely to compare it with a locally-constructed machine-scorable test designed to measure the same factor, Motor Coordination. GATB MM is highly-speeded and scored by counting the number of correctly made marks produced in one minutes. For a sample of 2,446 the mean score was 72.8, SD was 9.1.

(2) Motor Coordination (160 items, $1\frac{1}{2}$ minutes)

Mean score for 1,135 Ss was 54.6, SD 12.5. Unfortunately, as Table 2 shows, this test correlated only .38 with GATB MM and new variations of the same theme must be devised and administered again with GATB MM until a suitable machine-scorable equivalent is found.

(3) GATB Name Matching consisted of 150 items taken in 6 minutes and had a mean of 53.3 and SD of 12.7. Among the WPC verbal components with which it was compared were Spelling ($r = .39$), English Usage ($r = .32$), Reading Comprehension ($r = .27$), and Vocabulary ($r = .23$). These correlations substantiate the belief that NM measures something not in the current WPC battery.

(4) Perceptual Accuracy Test (48 items, 10 minutes)

Means were 8.17 Form A, 9.44 Form B; SD 3.10 for Form A, SD 3.32 for Form B. The number of cases used for the item analyses were 1,279 for Form A, 2,462 for Form B. Testing time was too limited which resulted in inadequate item analysis results for 22 of the 48 items, i.e., 22 items were omitted by 20% or more students in both samples. The highest score was 21 or 22. It is proposed that the 6 least discriminating and most difficult items from among the remaining 26 (with good item analysis data) be eliminated producing a 20-item pool of analyzed items. It is further proposed that the two most difficult items of the 22 imperfectly analyzed items be dropped to produce a

Table 2

Intercorrelations among WPC Experimental Tests Given Spring 1969

(Decimal points omitted)

	FMO	ANA	ANB	NM	PAA	PAB	MM	MC	Spe	MPA	MPB
GATB Forming Metal Objects		45	46								
Alpha Numeric Assembly A	995[a]										
Alpha Numeric Assembly B	904										
GATB Name Matching					33	36					
Perceptual Accuracy A				1218							
Perceptual Accuracy B				2329							
GATB Mark Making							38				
Motor Coordination						1238					
Spelling											
Mathematics Proficiency A											
Mathematics Proficiency B											

[a] N's below diagonal, r's above diagonal.

second pool of unanalyzed items. From each of these pools 10 items would be combined with 10 from the other pool producing two new 20-item experimental forms of Perceptual Accuracy each requiring 10 minutes testing time. Unanalyzed items would in each form precede analyzed items. As with GATB Name Matching the Perceptual Accuracy measures had low correlations (less than .30) with WPC verbal components (Table 1). The largest correlations with current WPC tests were, interestingly enough, with Applied Mathematics (PAA $\underline{r}$ = .35, PAB $\underline{r}$ = .33) and Mathematics Achievement (PAA $\underline{r}$ = .34, PAB $\underline{r}$ = .30). Perceptual Accuracy, however, correlated only .33 (PAA) and .36 (PAB) with GATB Name Matching (Table 2). It is hoped that more realistic timing of the shortened version of PA will provide a useful measure.

(5) GATB Forming Metal Objects was given to be compared with WPC Spatial Ability, another three-dimensional space ability test, and with the two-dimensional, experimental Alpha Numeric Assembly test. FMO consists of 40 items with a 6-minute time limit and yielded a mean score of 21.3, SD of 5.9, and KR-21 reliability of .82 based on 2,653 cases. Although FMO had a higher correlation with WPC Spatial Ability than with any other WPC measure, it was only .52. Thus, although both measure three-dimensional spatial visualization, they possess considerable uniqueness.

(6) Alpha Numeric Assembly Test (48 items, 10 minutes)

Means were 9.91 Form A, 12.85 Form B with SD 4.6 for both forms. For item analyses on Form A there were 1039 cases, for Form B 940 cases. Testing time proved too limited resulting in inadequate item analysis results for 13 of the 48 items, i.e., these 13 were omitted by 20% or more students in both samples. The highest score on the test was 29 or 30. It is proposed that the 5 least discriminating items among the 35 with completed item analyses (Form A 6 and 14,

Form B 6, 7, and 9) be eliminated and the remaining 30 items given in 15 minutes time. The 13 items with inadequate item analysis data, Form A 15 through 24, and Form B 22, 23, and 24, should be assembled with the 17 most discriminating items to form a second experimental form.

Alpha Numeric Assembly correlated less than .30 with all WPC current elements. ANA and ANB correlated .45 and .46 respectively with FMO (Table 2) although only .22 and .22 with WPC Spatial Ability. Only by shortening testing time, can Alpha Numeric be properly judged.

(7) Vocational Interest Inventory or VII (1969 Rev.) (112 items, 20 minutes)

This test was constructed to provide ipsative scale scores ranging from 0 to 28 on eight vocational interest groups as defined by Roe (1956). Roe's eight groups are:

1 Service
2 Business contact
3 Organization
4 Technology
5 Outdoor
6 Sciences
7 General cultural
8 Arts and entertainment

The first set of 56 items are occupations with socio-economic level controlled. Each interest group is presented 14 times with each group paired with every other group two times, thus a maximum of 14 points on any given group is possible from this section. The second set of 56 items consists of competing activities based on the 8 groups so that again each group is matched against each other group twice.

The item analysis data on which the 1970 version of the VII was based came from high school juniors tested in May 1968 (609 males, 581 females). The data were analyzed separately for the sexes so that items were modified on the following bases:

(a) Each item-scale correlation had to be positive and higher than any other r between that item and any other scale, e.g., item 36 used to read "(a) assistant caretaker in zoo" which was supposed to be most highly correlated with "science." For men it correlated with science .16, for women, .16. However, selecting "a" correlated .28 with "outdoors" among men, .30 among women. (On the other hand "b" which used to read "orderly" was clearly associated with "service," no problem.) But "a" had to be rewritten to get the outdoors out and science in at socio-economic level 6. The item now compares "diet kitchen helper" (science) with "nurse's aide" (service).

(b) In the above example "orderly" gave way to "nurse's iade" on the basis of a need to keep both an item's alternatives either neutral or stereotypically masculine or feminine so that choice would not be made on the basis of sex. By comparing the proportions of males and females endorsing alternatives, it was possible to reduce this confounding tendency, e.g., although item 24 was a good measure of technology using "bulldozer operator" (.33,.38), the percent of men endorsing this activity was 68, the percent of women 26. Clearly, bulldozer operator had to be replaced by some job in technology at level 6 which was more feminine, something as neutral as its alternative "sorting machine operator." It is hoped that "automobile upholstery cutter" will do the job.

It is proposed that the time limit be increased to 25 minutes (and the test scheduled at the end of the morning testing session) to permit students to finish the entire test. The VII is ready to be given all WPC participants.

When normative data are assembled summer 1970 score reports can be prepared and sent along with WPC test results for interpretation in the high school senior year. Results in standard score and ranking form will initially be attempted as the reporting format.

A summing up of recommendations with respect to WPC experimental testing spring 1970 includes:

(1) The battery can be divided into three Booklets (see page 8) each of which has a long and a short form. Each testing center should administer one long-form and two short-form booklets to permit enough experimental testing time with no loss in predictive accuracy from the current battery.

(2) The experimental tests to be used in 1970 should include revised versions of these tests given in 1969:

Spelling (could be considered a direct replacement)
GATB Mark Making (still needed in view of poor correlation for MC)
Motor Coordination
GATB Name Matching
Percentual Accuracy (2 versions)
GATB Forming Metal Objects
Alpha Numeric Assembly (2 versions)

(3) Assume the following six sets of testing centers the 1970 experimental tests should be distributed as follows:

Group A CWSC, Centralia, Edmonds, Seattle Community, Seattle Pacific, Whitworth.

Group B Columbia Basin, Ft. Steilacoom, Shoreline, Tacoma Community, WWSC.

Group C Everett, Grays Harbor, Green River, Highline, Yakima.

Group D Lower Columbia, Seattle Univ, Skagit Valley, Spokane Community, Walla Walla and Whitman.

Group E Bellevue, Clark, Olympic, WSU, Wenatchee.

Group F EWSC, Big Bend, PLU, Peninsula, St. Martins, UW.

Groups have been formed to provide approximately equal numbers of tested high school juniors (based upon 1969 testing) and geographical spread.

(4) Battery composition

The following is suggested for each of the above groups:

Group A: Long form Booklet I, short form Booklet II, short form Booklet III, Vocation Interest Inventory, Motor Coordination, Mark Making, Forming Metal Objects, Alpha Numeric Assembly (A).

Group B: Long form Booklet I, short form Booklet II, short form Booklet III, Vocational Interest Inventory, Motor Coordination, Name Matching, Perceptual Accuracy (A).

Group C: Short form Booklet I, long form Booklet II, short form Booklet III, Vocational Interest Inventory, Motor Coordination, Verbal Analogies (A)*, Forming Metal Objects, Perceptual Accuracy (B).

Group D: Short form Booklet I, long form Booklet II, short form Booklet III, Vocational Interest Inventory, Motor Coordination, Verbal Analogies (B), Name Matching, Alpha Numeric Assembly (B).

Group E: Short form Booklet I, short form Booklet II, long form Booklet III, Vocational Interest Inventory, Motor Coordination, Verbal Analogies (A), Spelling, Perceptual Accuracy (A).

Group F: Short form Booklet I, short form Booklet II, long form Booklet III, Vocational Interest Inventory, Motor Coordination, Verbal Analogies (B) Spelling, Perceptual Accuracy (B).

*Verbal Analogies A and B are 15-minute tests provided WPC by Lackland Air Force Base.

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